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A COMPARISON OF THE SIZE AND SPACE CONCEPTS OF BLIND AND SIGHTED SCHOOL CHILDREN

by
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A Thesis

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CHAPTER I

INTRODUCTION

The "meaningfulness" for the blind of customary verbal expressions of size, extent, and direction is of practical importance but no comprehensive experimental study has been made to determine its amount and accuracy. In approaching a study of the size and space concepts of blind children, the best method of investigation should logically be through a comparison of the accuracy of these concepts in blind children with the accuracy of these concepts in sighted public school children.

The analysis of such differences as may exist would have theoretical value in throwing light on the importance of visual experience in the development of such concepts. Knowledge of the limitations, if any, of blind children in the use of such concepts would be a practical aid to teachers in discovering what kinds of supplementary experience and training would be necessary in order to make meaningful in these respects that literature which is available to the blind. Finally, it might conceivably reveal deficiencies in the meaningfulness of such concepts for sighted as well as for blind children.

Concrete examples of the need for such a study appear daily in the class-room in schools for the blind. Blind students are constantly needing additional facts and information about places, plants, animals,

machines, and customs met in their reading, which lie outside their realm of experience. Public school children are often assigned reports from encyclopedias and other books of related subject matter which, with pictures and further information supplied by the teacher, familiarize the class with the new material. But the teacher is responsible for supplying all this to a group of blind children, as the source material of an informational kind, printed in Braille, the type read by the blind, is very limited. There are no raised pictures available. The reading texts used in schools for the blind are public school textbooks printed in Braille, devoid of illustration, and with no additional explanatory material.

Therefore, should the next story in the reader be Kipling's "Moti Guj--Mutineer", the teacher of the blind must gather information about the elephants of India and prepare it for her students in some terminology which will have meaning for herclass. Turning to the story itself, she finds:

> "three hundred pounds' weight of green food washed down with a quart of arr ck" (referred to as one of Moti Guj's meals)
>
> "waving a torn tree branch twelve feet long in his trunk"
>
> "Moti Guj curled the tip of his trunk, Chihun put his foot there, and was swung on to the neck."
>
> "Moti Guj lapped his trunk round Deesa and swung him into the air twice."
>
> "Moti Guj made fast and pulled up till the brown baby was crowing in the air twelve feet above his father's head."

The teacher's task is to acquaint her class with the size of the animal in this story and with as many other characteristics as she can. She may gather from her books of reference that:

> "The Indian elephants are usually about eight feet high at the shoulder, but occasionally exceed ten feet, and one was known to reach a height of twelve feet.
>
> A large elephant usually weighs about five tons.
>
> The body is very bulky in proportion to its height.
>
> The trunk is nearly eight feet long. With it the animal can reach objects on the gound, or for a distance of several feet in any direction.
>
> The tusks are incisor teeth, and weigh from one hundred fifty to two hundred pounds.
>
> The skin of an elephant is very thick, and dark brown in color. There is scarcely any hair."

By using what known heights can the teacher actualize the height of an elephant? Do her students know the height of a door--how much it exceeds their reach? How correctly do they know the height of a ceiling? Do they know their own weights, so these could beused as a basis of comparison for tusk weight? How accurately will statements in terms of other objects and in terms of linear measurement convey such information?

In order to gauge the accuracy of these size and space concepts in the case of blind students, we must know something of the psychological process involved in the development of these concepts. Hence it is relevant to examine first psychological investigations of these concepts in the normal individual, and then the psychological analysis of the space of the blind.

CHAPTER II

HISTORICAL SURVEY

We must turn first to Philosophy, from which Psychology derived its original concern with, and theories of, space. The earliest clear statement of theposition of British empiricists regarding space is contained in the theory advanced by Bishop Berkeley, in 1709. He believed that distance is not a primitive, but a derived intuition; that it results from observed visual variation concomitant with variation of space known in tactual experience.

Emmanuel Kant, German philosopher of the same century, took exception to this, and stated the position of the nativists, to whom space and time were a priori elements of experience. He said that "both space and time are original data of our sensibilty, and that the certainty of the laws of space arises not from the frequency of our experience of them, but from their primitive nature."

The Gestalt point of view is the best present-day representative of the nativist position. The Gestalt school posits original physiological mechanisms for the perception of space. Petermann quotes Kohler as saying, "All experienced order in space is a true representation of a corresponding order in the underlying dynamical context of physiological processes."

in 1910, said space was an outgrowth of the cutaneous sense, and articulation in that sense.

The limitations of touch, as compared with vision, have long been recognized. Wundt said tactual development was much slower than visual, and much more experience was necessary for tactual learning in the blind. "Their sensations of touch and movement have to construct the object gradually for them out of its parts." Judd, in 1907, said, "The limitations of the space perception of the blind appear when complex objects are presented for recognition." He mentioned the fact, which appeared only through trial, that reading of raised letters is much more difficult for theblind than reading the Braille alphabet, made up of different arrangements of dots. Lunz, in 1908, said,"The sense of touch does not take in very small objects, and those which are so large that they cannot be enclosed with the hand or show complicated form it only takes in gradually." Boring, in 1933, said, "The conscious skin is very patchy," but recognized the possibility of tactual experience as a foundation for space, as he said touch traditionally possesses extension, and evidence is furnished by the congenitally blind and by sighted observers who lack visual imagery. "Tactual and auditory phenomena can be localized with reference to a somesthetic frame, as they are in the case of the congenitally blind."

An experimental approach to the problem of whether the blind have the advantage of superior tactual sensitivity in developing concepts of space or not has been made through investigation of the two-point threshod in blind and seeing persons. Probably the bestpcontrolled, and most scientifically reported experimental work on this problem is that of Brown and Stratton, in 1925. After careful work on thirty-five blind children and fifteen sighted, they concluded that the tactual sensitivity of the blind was better than that of the sighted, and the congenitally blind excel those blinded later. They found no relationship between the sensitivity and the quality of school work done by the child. Their findings agreed with those of Czermak, Gartner, and others, and were opposed to those of Uthoff, Griesbach, Seashore, Haines, and others, who found the blind either inferior or merely equal to the sighted.

Several writers apparently realize the amount of material needed for an adequate organization of knowledge of theouter world which must oome through successive, active investigations. In 1891 Sully said that tactual perception of space is the product of movement and contact. He realized that developed tactual space does have three dimensions, and spoke of the hand as an organ of "active touch", and of the possibility of using the two hands in investigation of larger spaces or objects. Their activity is directed toward the purpose of gathering material to fit into the developing spatial organization. Through this two-handed activity, size, figure, and relative placement are gained. He

emphasized the important part played by movement in the localization of touch impressions and the tactual perception of space.

In 1907, Mellone and Drummond spoke of the developemtn of the space of the blind through passive touch, active movement, and exploration. They mentioned the use of the child's own body as a source for size measurements of external objects when he has become thoroughly familiar with it through the "double contact" of exploration. Through comparison, the child thinks of objects in the world about him as larger or smaller than some part of his won body.

James, in 1910, said that the space of the blind developed as a result of their movements and walking, with the kinesthetic part losing prominence. He thought it possible for some blind to have a co-existent organization, but reported the comment of a very intelligent blind friend that "to think of such distances involves probably more mental wear and tear and brain-waste in the blind than in the seeing." James found little use of devices such as thinking in map-terms, when considering a great distance, like the breadth of the country. He said that this was probably due to the lack of perspective in the thrid dimension of the blind, and their consequent habit of considering things always in their true size. Great distances are usually thought of in terms of necessary time for accomplishing the trip.

Stout, in 1924, noticed that some adult blind had not developed their methods of space investigation as highly as others, the amount of development being dependent on need. He said that all who had achieved a really effective method showed certain characteristics in common. He gave a description of their method of investigation objects, with the thumb and forefinger, and larger ones with the two hands. He said the power of organizing the spatial whole was more restricted in the blind then in the sighted but that simultaneous perception of a whole can occur in the blind. He spoke of space beyond the body as a question of organization of material gained from this active investigation, and said that the body is often used for comparison in determining the sizes of new objects.

Villey, in 1930, also mentioned these various possible ways of gathering characteristics of the outerworld, usually successively, and discussed their later organization. He, blind since early childhood, said his memory of a total object was co-existent[1], and spoke of the characteristic lack of kinesthetic attributes. He said an earlier German investigation had found such attributes quite unimportant in tactual memory. He also mentioned thework of Herr Fischer experimenting with various models of a tree, which clearly showed the greater importance of spatial relationships in comparison with kinesthetic and tactual detail in perceptions of the blind.

Persons possessing normal vision have always available (at least by day) many fixed visual points of reference in their spatial universe. In 1916, Haines reported a systematic study on this in connection with an intelligence test he was developing for the blind. He found that the totally blind child was markedly inferior to the sighted in a test in which the child was placed facing some compass direction, and asked to point to another. The partially blind made a better showing, using what little vision they had to "set themselves right", and identify some points of reference.

Sully said, "The ascertaining of a fixed spatial order among objects supposes that certain objects are at rest or occupy the same position." Cutsforth, in 1933, emphasized this same thing and spoke of the value to the blind of such things as a ticking clock, a dripping faucet, or wind chimes, as they are available without the child or person making an effort to find them. Villey said, "Sounds which emanate from fixed sources are much more valuable to him (the blind person), especially when they are permanent and not noisy.------The striking of the clock, its ticking, if loud enough, the crackling of fire in the grate, a door closing on the landing, or footsteps outside the room, and many other things, will rende him------service. And do not let us forget that all these familiar noises may cease to be

---

1. It is a point of discussion as to whether or not a congenitally blind person is able to have a co-existent simultaneous image of some large object or situation which he has experiences as a succession of parts. Villey claims that his image of the parts of a chair make a simultaneous whols.

perceived distinctly, as always happens with familiar sounds, and yet they will continue to play their role as indicators."

Pillsbury, in 1926, and Titchener both spoke of the importance of sound to the blind. Griesbach carried on an experimental comparison of them with sighted children, and found the blind could neither localize better nor hear farther. More recentexperimental work reported by Hayes in 1935, showed the blind better at sound localization than the sighted. The experimentation was carried on with forty-nine blind boys, fifty-four blind girls, and sixty college women. The blind excelled in localization of sounds directly in front, or directly in back. Blind boys, who enjoy greater freedom, excelled the girls. Hayes was uncertain as to how this sensory compensation ought to be explained.

The blind, through attending to slight differences in echoes and other sound qualities disregarded by the ordinary person, are able to infer many facts about their immediate surroundings. These probably give them size differences in different rooms and closed spaces. They are also able through practice to tell when they pass trees, posts, buildings, alleys, low walls, open doorways, etc, But the only systematic experimental studies available on the accuracy of this information are those dealing with the "obstacle sense.".

This sense warns the blind of obstacles by which theyare confronted, and hearing seems to have been proved the modality mainly responsible for it. This "obstacle sense" is of value to them as they move about relying on their spatial concepts. Hayes, in 1935, in his summary of experimental work on the "obstacle sense", summarized the work of Heller, Dresslar, MacDougall, A. Krogius, Kunz, LaMarque, and

Dolanski. Air pressure, appreciated by touch, may play a part, more in some persons than in others, but the wieght of evidence favors audition. Caldwell, in 1929, found indications that a screen door as an obstacle gave less warning to the blind than an ordinary door.

Their sense of smell also often helps the blind in identifying certain places. Characteristic odors, unnoticed by the sighted, tell the blind man where he is. Hayes mentioned the use of smell by the blind.

In the early part of the twentieth century, Stratton investigated his own space orientation and, through this, the accepted theories of space. He was interested in the space of the blind and with the question of whether it possossed charateristics in common with the space of the sighted. He also studied the cases where sight had been given to blind persons, through operation. In 1903, he told of an experimental attack on the organization of space perception through use of a pseudoscope which inverted vision and thus upset co-ordination between it and perception in other modalities. This made it necessary for him to form new motor habits, which he did, after continued practice. He also found that the ordinary person has much difficulty in recognizing familiar objects in a picture if light and shade are reversed. He concluded that visual space was developed, and after examining reported cases of newly-seeing persons, he concluded that sight and touch had spatial elements in common. For years cases have been cited of persons

who have trouble in recognizing the familiar through newly-acquired vision, after years of experience as a blind person. Sully, in 1892, had quoted Raehlmann as saying there is evidence that post-operative congental cateract cases develop visual perception in the same order as normal children. Besides the lack of visual experience, Stratton spoke of the extreme discomfort accompanying the first use of the eyes in an effort to see after such operations. He pointed the case of Franz's famous patient--a boy who recognized certain known geometric forms. The boy said it was done through tactual memory in the finger-tips, but the stimulation was visual, as Mahaffy also pointed out.

Carr, after describing Stratton's psuedoscopic work and results, said that vision itself cannot have inversion, as relationships are established with visual material and "upright vision, in the final analysis, is vision in harmony with touch and motor experience." But this does not invalidate Stratton's contention that the space of the blind is the same space as that of the sighted, the differences being in the modalities through which the responses to objects are mediated.

CHAPTER III

SUMMARY OF HISTORICAL SURVEY

AND

STATEMENT OF THE PROBLEM OF THIS STUDY

The literature, then, dealing with the basis and organization of the space of the blind infers that it is a group of concepts resulting from experience in the available modalities. The blind attend more closely to such sensory experiences as are available to them than is necessary for persons with the advantages of normal vision. The blind differ among themselves in the degree of development attained with reference to space concepts. This is largely determined by the amount of active investigation carried on by the individual. This again may be influenced by necessity, temperament, and intelligence.

The blind probably differ, as do the sighted, in emphasis on the different modalities making up their spaceconcepts. These concepts may be co-existent but simultaneity is probably a less common characteristic of the space of the blind than of the sighted. Some say the space of the blind is always a successive series, resembling their experiences.

There are experimental indications that the blind have a lower two-point threshold than the sighted, that they can localize sound better, and that they are able to use hearing to detect obstacles

in their path.

Certain limitations are also apparent. For example, the sensory experience possible to the blind is of smaller compass than that possible for those who have visual awareness of distances. It is more difficult for touch to appreciate complicated forms, very small objects, or very large ones. This is demonstrated by observation of the difficulty experienced by the blind in reading raised letters.

Auditory cues are used by the totally blind for general orientation, but the experimental evidence indicates that their larger space, involving compass directions, is quite faulty.

The accuracy of a blind child's knowledge of the sizes of objects within his experience should beopen to investigation. Is he able to express these sizes in terms of his own body, in terms of other objects he knows, or can he think well enough in terms of linear measures to make satisfactory use of the training he has had along such lines? How concrete for him are the sizes of things outside his actual, tactual experience and how accurately does he know them?

The purposes, then, of this study are:

1. To construct an objective test which will measure this knowledge and the child's ability to express it;

2. To administer this test to blind children in certain grades;

3. To administer it to a comparable group of public school children;

4. Through the results obtained, to judge the development of this ability in the blind.

5. To infer from this and other available materials the singificant relationships of such knowledge to what is known about mental organization.

CHAPTER IV

CONSTRUCTION OF THE TEST

A test constructed for such purposes should sample the ability of children to orient themselves in representative situations and to judge the sizes of objects encountered in everyday experience and in reading.

In regard to orientation for example, the left-right relationship is important to the blind because the terms are frequently used in directions for finding places, to to warn them of an obstacle. Compass directions are an application of this learned realtionship to locating objects in space which is used by the blind and sighted alike. Hence both are sampled in one section of the test.

In studying the accuracy of judgments about the size of objects it seemed desirable to select materials without reference to the likelihood of whether they would be included in a blind child's actual experience or not, in order to measure the relative knowledge of the blind and sighted children on a smapling representative of every-day life experiences. The chief source from which such materials were drawn was the names of objects and animals appearing in Throndike's list of most commonly used words. But practically it was found necessary to supplement the words listed by Thorndike with others which seemed equally important from the State Course of Study, and from certain readers used in the public

schools and the schools for the blind. Due to the nature of the sources for the word count, to the inclusion of undifferentiated homographs, and to the special needs of thisstudy, the inclusion of some items not ranking high in frequency of use was felt warranted, as standing of the blind was to be determined by a comparison with what public school children could do. The inclusion of some objects not common to the experience of all children would broaden the field surveyed without, in relative terms, putting the blind children at any particular disadvantage.

The test was prepared for use with fifty, sixth, seventh and eight graders. It was felt that fifth graders would be able to follow directions and would not be bothered by the mechanics of the test. It was desirable to give it to several grades in order to check on improvement with age and grade. Comparison of blind and sighted was to be by grade as theaabilities tested might be related to Educational Age.

In its final form, the test consisted of eight sections: Section A[1], made up of eight questions, dealt with orientation and is similar to Terman's Orientation test (Form L XIV,31) which came off the press shortly afterward.[2]

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[1] This section was in its present form before January 6, 1937.

[2] Terman, Lewis Madison and Merrill, M. A., Measuring Intelligence, (Houghton-Mifflin Company, New York, City, 1937.)

Example: "If South were to your right, what direction would you be facing?"

Section B was a list of twelve questions on sizes or dimensions of common objects, such as the width of a door, the height of a siz-year-old boy, etc. The directions for this section gave examples of size-telling in terms of parts of one's own body, in linear measure, and in terms of other objects. The student was free to use whichever method he chose on each question. The purpose of this section was to learn the frequency of use of each kind of comparison in this situation, and see whether there was any different expectation of response for a blind child than for a sighted. The answers were not checked for accuracy.

Section C asked for twelve estimates in terms of linear measure of such things as the length of the room in which the test was given, height of the teacher, width of a door, length of the child's hand, length of his foot, and his arm span.

Section D was made up of ten multiple choice questions concerning sizes, each giving a choice of three different objects for the answer, e.g. "Are apples about the same size as--watermelons, oranges, or lemons?"

Section E was similar to Section D, but the choice lay between three statements of linear measurem as "Are apple trees usually--thirty feet high, sixty feet high, or ninety feet high?" There were nine questions in this section, and several were on the same objects asked about in

objects asked about in Section D.

Section F was made up of eleven groups, each group containing four objects which were to be arranged in order of size. The list included groups of animals, fruits, vegetables, berries, and nuts.

Section G asked for outlines of foot and of hand, and furnished objective measures for checking on foot and hand length in Section C, and finger length in Section E. In Section H the child was asked to indicate the length of eleven objects by marks, and to write down his estimates of these lengths in inches. The objects varied in size from the width of a fifty-cent piece to the length of a table knife. Only items were included in this section for which a reasonably standard measurement was available, and a small range was allowed on those items where some variation exists.

On Sections A, D, F, and H sample questions were used, and the answers checked on, to make certain that the students understood the method of answering to be used in those sections.

CHAPTER V

ADMINISTERING THE TEST

The test was given first to public school children. Each child in the group was given a sheet of legal cap paper within which were clipped a copy of the questions in Section B, the list for Section F, two clean sheets of typing paper for the outlines in Section G, and two sheets asking for the sizes of objects included in SectionH, with places provided for the marking and estimating. Except for Sections B, F, and H, it was a dictated test. Each question was read twice. The directions for all sections were given orally. Further explanation was given if necessary. The test lasted about an hour and a half, the time varying with the group. It was preceded by a short explanation by the teacher, and general instructions by the tester. Each child headed his paper with the name of the school and his grade on the first line, his name on the second line, his age and birthday on the third. Two breaks were given during the hour-and -a-half period. Usually the teacher took charge for a few minutes after Section B, and after Section E, direction rest activity. Sometimes recess or a trip to another room for a music period, furnished the break.

The test was given to the fifth, seventh, sixth and eighth grades, in the order named, in Clatskanie, Oregon, to one hundred children; to the fifth, sixth, seventh, and eight grades, in onegroup, at the Chapman School, near Scappoose, Oregon, to a total of twenty-four children; to the sixth grade at the Washington Public School, in Salem, Oregon, to forty-two children. The test was given to twenty-eight fifth, sixth, seventh, and eight graders at the Oregon State School for the Blind, at Salem, Oregon, of whom six were totally blind, and twenty-two partially blind. It was given at the Washington School for the Blind, at Vancouver, Washington, to twenty-five children, of whom twelve were totally blind, and thirteen partically so. In these two schools, children were divided into totally blind and particlly blind groups for the taking of the test, the totally blind being tested first. Eleven children were tested who were eigher congenitally blind or who had lost their eight at too early an age to have any visual memory.

Section H was given individually in the schools for the blind. A roll of adding machine paper was used. The student was asked to indicate, by a fold, how far from the end of the paper a certain object would reach. The paper was then creased squarely across and cut, each time, and the child given the piece of paper to use while making his estimate. If he was dissatisfied with his first indication, he was allowed to fold again. The paper was then labeled

by the tester. Otherwise the testing procedure was similar to that in public school. Braille or Clear Type (a large, heavy type of printing) copies of Sections B and F were used, and the answers were recorded either with a Braille slate and stylus, or a heavy pencil. More time was required by the Braille groups, as their reading and writing rates are slower than those of students using print.

In the schools for the blind, and in the sixth grade in public school in Salem, the students were asked to indicate by underlining, or by a separate listing, those animals, fruits, etc. used in Section F which they had actually seen, eigher in real life, or in moving pictures, or had examined tactually, in the case of the blind.

A total of one hundred sixty-six public school students were tested, and fifty-three students in schools for the blind. The total number tested was two hundred nineteen.

Intelligence Quotients earned on the "Otis Self-Administering Tests of Mental Ability." Form A (a half-hour test) were available on the sixth, seventh, and eighth grades, Clatskenie, and the sixth grade, publich school, Salem. In Clatskenie this test had been given to the sixth and seventh graders two years before, to the eighth grade during the school year in which the testing was done, and to the Salem sixth grade several weeks after the test used in this study.

Metropolitan Achievement Test" scores were available for students in the eighth grade in Clatskanie. These include grade standings for each student for sections on "Arithmetic Fundamentals" and on "Arithmetic Problems."

CHAPTER VI

TREATMENT OF MATERIAL

A. Scoring

In the scoring, the sections were dividen into two tests, known as Test 1 and Test 2. Test 1 was made up of Sections A, D, E, and F.

The score on Section A should indicate how accurately the student can think in terms of compass directions and left-and-right. The score on Section D will show how well he knows the sizes of objects in terms of other objects. while Section E indicates his size-knowledge in terms of linear measure. The standing of a student on Section F will indicate how well he can compare the sizes of widely differing objects, many of which he has never experienced together.

The first scoring was done giving one credit for each correct answer in A, D, and E, and a score of two[1] for a perfect arrangement of a group of four items in Section F.

For checking on Question 408, Section E, "Is your little finger between one and two, two and three, or three

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[1] The scoring procedure recommended by Conrad, of California, for the re-arrangement test, was used.

and four inches long?" the little finger was measured on each hand-outline, Section G. If the measurement was not more than one-fourth inch beyond eigher of the two limite given, the answer was counted correct.

Test 2 was made up of Sections C and H. Scoring was done in percents of error. The true measure for each question in C was divided into the stimated measure. The true measure of each item in H was divided into the marked length, and then divided into the estimated length, also. The score recorded in each case was the difference from one hundred per cent.

A low average error on Section C would indicate proficiency in using conventional unite to judge a range of distances the upper limit of which was the length of the room. A low average error of estimate on Section H would indicate proficiency in using similar unite to judge dimensions of small objects while the average error of marking would show how well the correct size could be reproduced.

Over-estimations were recorded with a plus sizn in scoring, but in the treatment of material, sizn was disregarded, no difference being made between an under-estimation and an over-estimation resulting in the same percentage of error.

The unit with which the per cent of error was determined varied with the question. The true dimensions of the room were taken to the nearest foot, and the calculation was done in terms of fact. A question on window height was omitted, as some school-rooms had windows of different heights in the same room. Window width, table height, and teacher height were all calculated in inches. The questions on the child's own height, and whether or not he was sure of it, wer not corrected. Lists of the latest recorded heights of the members of each class were secured from the teachers, and these used as a basis for checking the accuracy of the arm-span estimate. In order to establish the normal limits of expected variation between height and arm-span in children in these four grades, measures of height and of arm-span were secured on all twenty-four students in these grades by the teacher at the Chapman School. The sigma of the differences between arm-span height for these twenty-four children was found to be 1.36 inches. This standard of accuracy was considered sufficiently general to justify using it for all children as well as for the twenty-four from whose measurement it was derived. So an allowance of three sigma in eigher direction made a score correct if the arm-span estimate varied not more than four inches from height. The figuring was done in inches from the nearest four-inch limit. The

questions on hand and foot lenght were corrected in terms of inches, the acutal length being taken to the nearest inch.

In Section H the unit throughout was one-eighth inch.[1] The first item, a blackboard earaser, was not checked. It had been used for demonstration, although the actual length had not been stated.

The true lengths used were: (in eights of inches)

Length of a dollar bill--forty-nine

Width of a dollar bill--twenty

Width of a silver dollar--twelve

Width of a fifty-cent piece--nine

Length of an egg--eighteen to twenty-two

Length of a table fork--fifty-eight to sixty-two

Length of a table knife--seventy-two to seventy-six

Lenght of a teaspoon--forty-four to forty-eight

Height of a drinking glass--twenty-four to thirty-two.

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[1] In his early experimentation Weber established 1/100th as the fractional increase necessary for a J. N. D. in line length. Fechner, later, stated that the fraction might be as large as 1/50th for some individuals in lines ranging from 2/5 to 9 ½ inches. This range includes all the lengths marked in H$_1$. (Ladd and Woodworth, Elements of Physiological Psychology, (New York, Chicago, Boston: Charles Scribner's Sons, October, 1915) p. 360, p. 371.)

A unit of 1/8 inch gave results accurate enough for noticeable variations to appear, and the marked end estimated lengths could be easily reduced to this unit.

The question on width of a slice of baker's bread was not use, due to difference between some large and small loaves, and the confusion of thickness and width on some papers.

B. Statistical Treatment

In the group of six scores (those on Sections A, C, D, E, F, and H) earned by each student on the entire test, those earned on Sections C and H were of a similar kind. Each of these sections asked for estimates of certain dimensions in terms of linear measure, whil Section H also asked for the lengths to be marked. After these sections had been scored, the final standings were average percentages of error of estimate. The more accurately the person had estimated, the smaller his score.

On the other sections, the higher scores indicated better standing in the thing tested. Sections A, D, E, and F offered the possibility of forming a battery, as each theoretically investigated a different aspect of development in the size and space concepts of the individual. By using a pool, the effects of particular experiences peculiar to some individuals and not to others would be lessened. But the logic of pooling would also require some generality in the separate aspects to be combined in a single measure. Hence the first step in deciding how these scores should be treated was to intercorrelate each of these sections. If the intercorrelations between certain sections were very high, then these would in reality be testing the same thing, and need not all be included. If they were practically zero there would be little warrant for pooling them.

Therefore the standings of a group of one hundred eighteen publisc school children--on orientation, knowledge of sizes in terms of other common objects and in terms of linear measure, and arrangement in order of size--were intercorrelated. The Pearson product-moment method was use. The resulting r's (See Table I) ranged from.151 with a sigma of .061, to .478, with a sigma of .148.

TABLE I

Showing Intercorrelations of Sections A,
D, E, and F, and the Reliablility of Test 1
as Established by Correlating Scores on
Alternate Items of the Battery as a Whole

N=118

Correlation	Grade	School	r	σ_r
A and D	6-8	Public	.12	.06
A and E	6-8	Public	.17	.06
A and F	6-8	Public	.17	.-6
D and E	6-8	Public	.21	.06
D and E	6-8	Public	.37	.05
E and F	6-8	Public	.48	.05
Odds and Evens	6-8	Public	.37	.05

Reliability of Test I estimated from this self correlation $^{r}1_{I}=.54$ with standard deviation of .08*
The intercorrelations indicate that these sections test fairly independent aspects of the abilities studied; this is reflected again in the comparatively low reliablity of the whol test which is barely high enough to justify the use of the test for group comparison.

There were four grades with available Intelligence Quotients. Their records were used to intercorrelate the sections and establish the reliability. The relation of I. Q. to this test could then be learned later. The sixth, seventh, and eight grades in Clatskanie, Oregon, and the sixth grade in Salem, Oregon, were the ones used.

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* $\sigma_{r_{1_I}}=$ estimated from self correlation $-\frac{2(1-r)}{\sqrt{N}}$

Eugene Shen, Standard Error of Estimated Correlation Coefficients, Journal of Educational Psychology, (1924,) p.462.

As indicated in the table above the total credits on the odd items in the four sections (A. D. E. and F) were correlated with the total credits on the even items, for this same group. The Spearman-Brown formula was then used to estimate the reliability of this combination of tests as a whole. Kelley, in his "Interpretation of Educational Measurements", says that tests with a reliability of . .5 may be used for group comparison.[1] The correlation of the alternate items in the test resulted in a self-correlation of $r = .37$. Hence the estimated reliability coefficient for the test as a whole should be $r_{1_1} = .54$. (See Table 1.) Although the reliability of these four sections combined turned out to be lower than was expected, it meets the standard considered satisfactory for group comparisons. The intercorrelations are low enough so that no section should be omitted but high enough to justify pooling, especially if the effect of low reliability in each section is allowed for.

Frequency tables were next made of group standings on each of these four sections. It was necessary to learn the mean score and sigma on each section in order to know whether a simple summation of scores whoul be reasonable or

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[1] . T. L. Kelley, Interpretation of Educational Measurements, Formula 54, p.211.

whether some sections should be weighted. Since no criterion of the relative importance of the four tests was e available, differences in variablity were all that needed to be consideree in deciding this matter.

The group whose scored were to be used in this table whould be the same group to which the blind childeen were to be compared. The four grades in Clatskanio and the one public school grade in Salem contained a total of one hundred forty-two students, whose scores were used for this purpose. Frequency tables were constructed from their standings on each of the four sections. The sigmas thus found were so nearly equivalent in proportion to the number of items in each section that no differential weighting was used. (See Table II.)

TABLE II

Showing Mean Scores and Sigmas on Sections A, D, E, And F for Public School Group

Section	N	Total Possible	M	σ
A	141	8	6.6	1.14
D	141	10	7.4	1.56
E	141	9	6.4	1.40
F	141	22	18.1	3.08

There is no great variation in sigma in relation to the number of items in each section , so the sum of the scores on these four sections will be treated as the Test 1 score. The possible score on Section F is the greatest, as it offered an approach to a wide variety of objects.

One paper was omitted from these frequency distributions, that of a fifth grader not used on Test 2. Otherwise the entire fifth, sixth, seventh, and eighth grades in Clatskanie, Oregon, and the Public school sixth grade in Salem, Oregon, were used.

The totally and partially blind should no be treated together as one group if there are characteristic differences in their scores on any section. Several things might influence these standings. If vision were the allimportant factor, the partially blind would make consistently better scores than the totally blind, and poorer scores than public school children. Those totally blind since birth or infancy would make poorer scores than those blinded later. Or if there should be a difference in classroom techniques and every-day experience between schools for the blind and public schools which affected scores on these tests, students in schools for the blind, whether totally or partially blind, should make poorer scores than those in public schools.

Frequency tables were made of the scores of all the totally blind children on each of these four sections, and of all the partially

blind. The mean scores of the totally blind were slightly higher on three of the four sections, but there was no statistically significant difference on any. The amounts of variation were practically the same on the two groups, the sigmas being slightly higher for the totally blind on two sections, and for the partially blind on two. (See Table III). Because of the similarity of scores of the totally and partially blind, it was considered legitimate to make the comparisons between public school children and those in schools for the blind.

TABLE III

SHOWING THE MEANS AND SIGMAS OF THE TOTALLY AND PARTIALLY BLIND GROUPS ON SECTIONS A, D, E, and F

T-Totally Blind
P-Partially Blind

Section	N	Group	Total Possible	M	σ
A	18	T	8	6.7	1.60
A	35	P	8	6.9	1.40
D	18	T	10	7.0	1.76
D	35	P	10	6.9	1.61
E	18	T	9	7.1	1.13
E	35	P	9	6.9	1.53
F	18	T	22	17.2	2.65
F	35	P	22	17.1	3.61

The scores on these two groups are very close, the means of the totally blind being slightly hihger on three of the four selections.

The students from both schools for the blind were considered together and those no more than barely able to perceive light were classified as totally blind.

We are now ready to compare the blind group with the sighted group on their total scores on the pooled material contained in Sections A, D, E, and F, known as Test 1. Comparison was made by grade as the general achievement level of each grade is intended to be the same in schools for the blind as in public schools. Frequency distributions were made for the fifth, sixth, seventh, and eighth grades in schools for the blind and likewise in public schools. (See Table IV.).

TABLE IV

Showing Means and Sigmas by Grade,
of Sighted and Blind Students on Test 1

Grade	School	N	M	σ
5	Public	23	34.1	6.08
5	Blind	14	35.9	6.24
6	Public	58	38.1	4.84
6	Blind	13	38.6	4.26
7	Public	24	40.6	3.66
7	Blind	10	40.1	3.46
8	Public	34	40.8	3.74
8	Blind	15	39.5	5.06

This comparison shows no general superiority of sighted students in the kinds of knowledge sampled by Test 1. Their average means was 38.39. The average mean of the blind was 38.53. The blind are slightly more variable, with an average sigma of 4.76. The average sigma of the sighted grades was 4.58.

The scores of all blind students were used. The scores of one Clatskanie Fifth grade student and two Salem sixth grade students were omitted from the public school groups. These were students whose scores on Test 2 varied so widely from the general distribution that they were not included there.

An examination of Table IV shows that:

1. There is a progressive increase in scores earned by public school children on Testl, from the fifth to the eighth grades inclusive.

2. There is a similar progressive increase in scores earned by children in schools for the blind, with the exception of the eighth grade.

3. The variability of the scores of children in public schools decreases from the fifth to the seventh grade.

4. There is a similar decrease in schools for the blind with noticeable increase in the variability of scores made by children in the eighth grade.

5. The means of public school students are very close to those of students of the same grade in schools for the blind. The blind have slightly higher means in two of the four grades.

Section F provided a means of learning to what extent the score earned depended upon familiarity with the materials of the test. The sixth grade in the Washington Public School, at Salem, Oregon, had underlined those things in this re-arrangement section which they had actually seen. Thus the number of objects seen could be correlated with the score on this section of the test. (See Table V.)

All students in both schools for the blind had either underlined or listed those objects which they had seen or examined tactually. The number of concretely experienced items was correlated with their scores on this section as appears below.

TABLE V

Showing Correlation of Section F
Score with Items Seen or Examined

Grade	School	N	r	σ
6	Public	40	.54	.08
5-8	Blind	50	.47	.07

The forty-two students in the public school sixth grade, at Salem, Oregon, had underlined the Section F items they had seen,but two of the papers were incomplete, so could not be used. All students tested in schools for the blind had either underlined or listed these items, but two of these papers were incomplete.

The r of .54, with a sigma of .08, obtained in the case of the public school children shows a fairly definite relationship between the degree of familiarity with materials and the knowledge of their relative sizes. In the case of the blind, r equals .47 for these two variables, indicating that their knowledge is not quite so closely related to the amount of concrete experience they have had with such materials. The difference in the size of these two correlations might have occurred by chance.

We next wished to learn whether the development tested by the four sections of Test 1, were related to other measurable capacities or skills. We therefore correlated thetotal scores made on Test 1 with the Intelligence Quotients of the one hundred four public school children for whom they were available.

Quotients of the one hundred four public school children for whom they were available. We also correlated the Test 1 scores with the arithmetic standing on the "Metropolitan Achievement Tests" for the thirty-one public school children who had taken it.

These correlations would have been considerably higher had the test sections been lengthened so as to increase their reliability.

TABLE VI

Showing, through Correlation, the Relation of Test 1 Scores to Intelligence Quotients, Arithmetic Fundamentals, and Arithmetic Problems

Corr. with	Grade	School	N	r	σ
I. Q.	6-8	Public	104	.43	.05
Arith. Fund.	8	Public	31	.47	.09
Arith. Prob.	8	Public	31	.18	.12

These correlations show that excellance in the developments of size and space concepts sampled in Test 1 is related to Intelligence Quotient and to group of Arithmetic fundamentals.

Of the one hundred eighteen students in the sixth, seventh, and eighth grades at Clatskanie, Oregon, and the sixth grade at Salem, Oregon, Intelligence Quotients were available on one hundred four. These Intelligence Quotients were derived from Otis Self-administering Tests of Mental Ability. The eighth grade at Clatskanie, Oregon, took the "Metropolitan Achievement Test" at the end of the school year. From this test, each student had a grade placement in years and months in "Arithmetic Fundamentals" and "Arithmetic Problems". Complete records were available on thirty-one of the thirty-four students.

The statistical treatment thus far has dealt with Sections A, D, E, and F and has not touched on Sections C and H. As explained previously these two sections asked for estimates in the linear units of certain familiar objects. On the whole the questions in Section C dealt with larger objects than those in Section H. The score on each object was recorded as a per cent of error; therefore smaller scores indicated closer estimates. The students had also indicated by marks the lengths of the objects used in Section H. These were recorded as per cents of error and were known as the H 1 scores in order to differentiate them from the estimates, or H 2 scores.

In order to investigate the possible makeup of a test which would be useful for group comparisons, the average scores on Sections C, H 1, and H 2 were intercorrelated on the same group of one hundred and eighteen school children whose papers were used in investigating material for Test 1.

These intercorrelations were figured from rank orders, and were low enough to justify the inclusion of all sections. (See Table VII.)

Considered from a logical standpoint, however, the C and H 2 sections sample a more commonly used ability than does H 1. A person ordinarily has many more occasions to estimate distances in feet and inches, or to

interpret such symbols, than he has to show his ideas of dimensions by marks. Moreover the H 1 scores seem to have very little if any real relationship to the scores on Section C. Presumably also there would be a good deal of commonality between the H 1 marking scores and the H 2 scores because of the identity of the articles marked in H 1 and estimated in H 2. Hence it seemed desirable to omit H 1 from any combination of these sections. The relationship of H 1 to the other sections is presented later. The low intercorrelation between C and H 2 indicates a great specificity of knowledge in terms of linear units.

Showing intercorrelations of C, H 1, and H 2,
and Reliability of Test 2, on Public School Group

C--Error in estimating large distances
H 1--Error in marking small distance
H 2--Error in estimating small distance

Corr.	H	r	σ	Corrected r
C and H 1	118	.091	.062	
C and H 2	118	.262	.058	
H 1--H 2	118	.312	.056	
Odds & Evens	109	.622	.04	.767

These correlations are low, surprisingly so between C and H 2.

The reliability of a test made up of these two sections is however considerably better than that of Test 1.

These correlations are on the sixth, seventh, and eighth grades, Clatskanie, Oregon, and the sixth grade, Salem, Oregon (Washington School). Nine incomplete papers were not used on the reliability correlation, as the odd and even scores were in terms of totals, rather than averages.

All these correlations were done from rank order arrangements.

The reliability was found by correlating the totals on odd items against the totals on even items for those papers which were complete. The reliability of a test made up of these two sections is noticeably higher than that of Test 1. It should therefore be entirely satisfactory for group comparison.

Frequency distributions were made of the averages

on the nineteen items in Test 2 for students in both public school and schools for the blind. This comparison, like that in Test 1, was done by grade. (See Table VIII.)

The Test 2 scores of three public school students and one blind student were so far beyond the group's range of average error that they were not used in the following comparisons.

TABLE VIII

Showing Means and Sigmas, by Grade,
of Sighted and Blind Students on Test 2

Grade	School	N	M	σ
5	Public	23	34.3	16.41
5	Blind	14	22.3	4.27
6	Public	58	26.1	11.09
6	Blind	13	22.5	8.10
7	Public	24	20.0	7.29
7	Blind	10	23.8	8.86
8	Public	34	18.5	5.51
8	Blind	15	23.3	15.84

These means show a steady improvement from the fifth through the eighth grade in ability of public school children to estimate dimensions. Their variability decreases. No similar improvement appears in the case of blind students.

The same groups were used for this comparison as in Table IV. The public school range was from 6% to 74%. One fifth grade score of 120.32% and two sixth grade scores of 124.79% and 122.91%, respectively, were not used. The blind students' range was from 4% to 72%. One eighth grade score of 283% was not used.

These four students evidently had either no idea, or very erroneous ones, about the quantities signified by feet and inches.

An examination of Table VIII shows:

1. There is in public school a progressive improvement by grade in accuracy of estimate on the material in Test 2.

2. The Test 2 scores of blind students do not show this improvement.

3. There is a decreasing amount of variation in public school score, by grade.

4. The tendency is toward increased variation in the blind group tested.

5. The mean score of the blind fifth grade was decidedly better than that of the public school fifth grade. Their sixth grade score was also better, but the difference was less. The public school seventh grade had a better mean score than the blind, as did also the eighth, by an increased margin.

The proportion of totally blind students progresses steadily from the lower to the upper grades in the group used for this test. This fact might be related to the lack of improvement in the group from schools for the blind.

To determine this, the scores of the totally blind and of the partially blind in each grade were averaged. (See Table IX.) The totally blind groups were too small to justify any general conclusions, but the mean scores of

the blind-school group were not appreciably changed by them.

TABLE IX

Showing Average Errors of the Totally Blind and of the Partially Blind, by Grade, on Test 2

Grade	Group	N	M	Range
5	T	3	25.3	21-32
5	P	11	23.5	14-48
6	T	4	20.5	13-28
6	P	9	20.4	6-38
7	T	3	22.3	15-29
7	P	7	29.3	11-73
8	T	7	20.4	9-44
8	P	8	24.9	9-66

The means of the totally blind were better than those of the partially blind in the seventh and eighth grades. It was these grades whose means were excelled by the public school group (see Table VIII).

Another possible comparison of the scores on Test 2 made by public school and blind children is in the kind of errors, whether they are under-estimations or over-estimations. Errors of over-estimation were recorded with a plus sign at the time of scoring. Although sign was disregarded in figuring the scores for Test 2, the per cent of over-estimations could be learned by going through the individual records, counting the plus errors, and dividing by the number estimated. At the same time a similar count could be made of the scores on H 1 and the per cent of

over-marking learned.

This procedure was followed and Table X shows that under-estimating and under-marking were characteristic of both groups. (See Table X.) The public school fifth and sixth graders over-estimated slightly more than these grades in schools for the blind, and the seventh and eighth graders slightly less. The difference between public school and blind groups was greater on H 1, the blind students over-marking more than the sighted. The blind students over-marked more than they over-estimated, the sighted less.

TABLE X

Showing the Percentages of Over-estimating on Test 2 and of Over-marking on H 1, for Public School and Blind Students, by Grade

Grade	School	N	% Plus Estimates	% Plus Markings
5	Public	24	32	18
5	Blind	13	25	42
6	Public	47	32	15
6	Blind	13	30	44
7	Public	21	20	12
7	Blind	10	23	32
8	Public	30	25	15
8	Blind	15	28	38

This table was constructed to show the *kinds* of errors, rather than amounts. Under-estimating and under-marking were characteristic of all. There is more differentiation between blind and sighted on marking than on estimating. The sighted have fewer over-markings than over-estimations; the blind have more.

All papers having complete records on C, H 1, and H 2 were used.

Although the H 1 scores were not included in Test 2, frequency distributions were made on these for public school students and for those in schools for the blind, by grade. (See Table XI.)

Public school students seem to improve between the fifth and sixth grades, but otherwise the mean scores were quite uniform. The sigmas were rather erratic, the blind tending to vary less.

Showing Means and Sigmas, by Grade, on H 1 Scores
for Public School and Schools for the Blind

Grade	School	N	M	σ
5	Public	22	24.2	7.75
5	Blind	14	15.1	4.63
6	Public	58	16.4	6.27
6	Blind	13	15.2	6.32
7	Public	24	16.3	9.30
7	Blind	10	17.0	8.16
8	Public	34	15.2	5.68
8	Blind	15	14.0	3.78

There is no general improvement in ability to indicate size, with the possible exception of the improved score in the public school sixth grade.

The records of the usual four public school grades were used, with the exception of the four papers omitted from Table VIII, and one additional fifth grade paper which also varied too greatly.

Section B was a group of questions asking for the sizes of different things. Each question could be answered through comparison to dimensions of one's own body, through use of linear measure, or through comparison to other objects. Counts were made of the numbers of times each kind of size-telling was used, and the percentages figured. (See Table XII.)

Linear measure was by far the most commonly used; the blind used it more than the sighted in all grades except the eighth.

TABLE XII

Showing the Percentages of Three Kinds of Size-telling on Section B, by Grade, for Public School and Blind Groups

Grade	School	N	Body Meas.	Linear Meas.	Other Objects
5	Public	24	6%	70%	24%
5	Blind	14	3	80	17
6	Public	42	9	65	26
6	Blind	13	2	81	17
7	Public	24	6	78	16
7	Blind	10	4	87	10
8	Public	34	4	79	17
8	Blind	16	9	70	21

"Linear measure, other objects, body dimensions" was the order of preference for these kinds of size-telling, in this test situation, in both public schools and schools for the blind. The amount of preference, indicated by this order, was marked, and somewhat more decided in the blind.

The papers of the entire fifth, seventh, and eighth grades of Clatskanie, Oregon, and the sixth public school grade of Salem, Oregon, were used in figuring these percentages. The papers of all the children tested in schools for the blind were used.

No differentiating count was made on totally blind and partially blind.

By using this Section B count, it was possible to correlate the number of questions on which linear measure was used with the score on Test 2. This would show whether a tendency to use linear measure was accompanied by accuracy in its use. (See Table XIII.)

This correlation showed a slight relationship of use to accuracy in the public school group, and a still slighter one in the case of the blind group.

TABLE XIII

Showing Correlation of Use of Linear Measure on Section B with Test 2 Score

School	N	r	σ
Public	139	.33	.05
Blind	52	.16	.09

Public school students who used linear measure the most in size-telling were somewhat more likely to be accurate than those who used it less. This tendency was slighter in the blind.

The groups used for these correlations were the same as those in Table VIII.

Test 1 had been found to have an r of .43 with a sigma of .05 with Intelligence quotients; an r of .47 with a sigma of .09 with "Arithmetic Fundamentals" and an r of .18 with a sigma of .12 with "Arithmetic Problems" (Metropolitan Achievement Tests). Test 2, with higher reliability, was correlated with these same scores. (See Table XIV.)

These correlations show considerable lack of relationship. Accuracy is estimating dimensions and distances is evidently more dependent on specific experiences than on general intelligence, or on proficiency in

general arithmetical procedures.

TABLE XIV

Showing, through Correlation, the Relation of
Test 2 Scores to Intelligence Quotients,
Arithmetic Fundamentals, and
Arithmetic Problems

Corr. with	Grade	School	N	r	σ
I. Q.	6-8	Public	104	.03	.07
Arith. Fund.	8	Public	31	.27	.11
Arith. Prob.	8	Public	31	.34	.11

Intelligence Quotient has no predictive value for ability to estimate in linear units, as measured in this test. The low r's and high sigmas show no real relationship between this ability and the two measures of Arithmetic skill.

The groups used in these correlations were the same as those used in Table VI.

Test 1, with low reliability and fairly high r's with these outside standardized measures, was next correlated with Test 2, which had a higher reliability but low r's with these other scores. (See Table XV.)

Considering the reliabilities of Test 1 and of Test 2, their r is quite high in the public school group. It is significantly lower in the group from schools for the blind.

TABLE XV

Showing Correlation of Test 1 and Test 2 Scores for Sighted and Blind Groups

School	N	r	σ
Public	139	.57	.04 .06
Blind	52	.31	.05 (.13)

A public school student making a good score on one test is more likely to make a good score on the other test than is a similar student in a school for the blind.

The groups used in these correlations were the same as those used in Table VIII.

Throughout this study the blind have been compared consistently with public school children of their own grade. Frequency distributions were made of the ages in each grade in order to determine the amount of retardation in schools for the blind. (See Table XVI.)

The average student in a school for the blind was found to be about one and a half years older than a public school student in the same grade (in the particular schools tested). The spread was greater in schools for the blind.

TABLE XVI

Showing Means and Sigmas on Age for Each Grade in Public School and in Schools for the Blind

Grade	School	N	M	σ
5	Public	23	11.4	1.21
5	Blind	14	12.7	1.19
6	Public	58	12.0	.95
6	Blind	13	13.7	1.53
7	Public	24	12.9	.53
7	Blind	10	14.4	1.42
8	Public	33	14.8	.71
8	Blind	15	16.3	1.82

The means for ages of the blind children in each grade were about one year and a half more than those of the public school children. They also varied more.

The age at the nearest birthday at the time of taking the test was used in making these distributions. All papers containing the necessary information were used.

It would be possible to sort the data according to age, rather than grade, for both Test 1 and Test 2.

CONCLUSIONS

The conclusions are that:

1. There are no characteristic differences in score between blind and sighted children in the same grade on Test 1.

Judgments of space and size sampled in this test appeared to be quite specific. Low intercorrelations between the various sections, and the low reliability of the test as a whole, are evidence of this fact.

2. In the public school group, the ability to estimate dimensions in linear units as sampled by Test 2 improved steadily in each grade (from five to eight). In the case of the children in schools for the blind, there is no such improvement. In the fifth grade these children excel the public school children, in the sixth grade they are superior by a much smaller margin, in the seventh grade the relationship is reversed though with but a slight margin, while in the eighth grade this superiority of public school children is quite large.

A similar change takes place in the homogeneity of the two groups as shown by changes in the Standard Deviations of the scores made by each grade. In the fifth grade the children in schools for the blind are much more homogeneous, as well as more capable than the public school fifth graders. In the eighth grade this relationship is

completely reversed and the change has come about gradually, grade by grade.

3. In marking off on paper the dimensions of familiar small objects, children in schools for the blind do as well as public school children and they surpass them slightly in the fifth grade.

4. Section F (arrangement according to size) included data showing the amount of concrete experience with the materials used. This correlated r=.54 for the public school children, and r=.47 for children in schools for the blind, with the scores on this section. In view of the low reliability of the test, the correlation of experience with accuracy would be practically perfect, if corrected for attenuation.

5. Linear measure was used in preference to other objects, or body dimensions as a means of size-telling (range for different grades--65% to 87% on Section B.)

The number of times linear measure was used was not closely related to accuracy in estimating, (r=.33 for the sighted group; r=.16 for the blind group). Thus the habit of depending on linear measure is only slightly justified by superior precision in using it.

6. Scores on Test 1 were related to scores on Test 2 (r=.57, sighted group; r=.31, blind group). The estimated true correlation between Tests 1 and 2 is .9.

The scores on Test 1 were also related to group test Intelligence Quotients. ($r=.43$)

The correlation of Test 2 with Intelligence is negligible. ($r=.03$)

Grasp of Arithmetic Fundamentals was more related to Test 1 ($r=.47$) than to Test 2 ($r=.27$).

Skill with Arithmetic Problems was more related to Test 2 ($r=.34$) than to Test 1 ($r=.18$).

7. It is apparent that the size aspects of those objects used in Test 1 can develop, in relation to each other, without vision. This study gave no check, however, on the amount of additional emphasis and instruction on this given by families and teachers of children in schools for the blind. The Test 2 results may be due to early emphasis in the case of children in schools for the blind, and to a later growth, through experience, in the case of public school children.

CHAPTER VII

Suggestions for Further Study

Probably the first step in continuing this study of the ability of school children to use size and space concepts would be the improvement of the test itself. Since the correlation between random halves of Test 1 is quite low it would be desirable to sample performances involving such concepts much more extensively. This would involve collecting as large a reservoir as possible of representative items of the type used and the addition of others measuring any aspects in the school use of size and space concepts which may have been overlooked.

The construction of such a reservoir should provide for a more objective selection of relevant words from the Thorndike list. This could be done by using only the words which competent judges agree have significant size and space connotations. A much more extensive count of similar words appearing in readers and other textbooks used in instructing the blind should also be made. The lists derived from these two sources could then be checked against each other and a procedure for making an appropriate sampling of them worked out.

Item analysis could be used to eliminate questions showing close relationship to "general intelligence". However any performance on the conceptual level is quite certain to involve intellectual ability and it may not be feasible to eliminate it as an important factor in appreciating size and space relationships. If not, it could be determined whether judgments of such relationships are more nearly akin to the pool of abilities measured by "performance" or by "verbal" tests of intelligence.

Any use of the test as a means of diagnosing individual deficiencies would require extending the sampling provided by Test 1 sufficiently to raise the reliability from r_{1_I} (estimated) equals .54 to approximately r_{1_I} equals .9. Unfortunately this would seem to require about eight times as extensive sampling as Test 1 now provides.

GENERAL INSTRUCTIONS

I have a test here which I want to give you. It is in eight different parts, or sections. Before we start on the first one, I weel tell you where to write your name and how to write your answers.

You each have a sheet of legal cap paper, like this one. (Show piece of legal cap.) As you write on it you should always have this red line (indicate red line) on the left. On the top line write-------------(write name of school on blackboard), Grade------(write grade number on blackboard). On the second line write your first and last names. On the third line write how old you are and when your birthday comes. In the middle of the fourth line write a capital A. (Pause each time directions for writing are given.) The first part of this test is called Section A and your answers to that part of the test will start on the next line after the letter A, over at the left hand side.

I am going to read the questions to you and I will read each one twice. I will read the number of the question first and you are to put this number out in the margin at the left of the red line. Listen carefully so you will have the right numbers. All your answers will come at the right of the red line. Take a new line for each new question. Do not

start writing until I have finished reading the question the second time.

Before we start on Section A, find the two sheets of clean typing paper and write your first and last names at the top of each of them. Then find the sheets numbered 13 and 14 and write your first and last names at the tops of them. Do not write on the other two sheets. When you have your name on these four sheets, lay all the typing paper under your legal cap and be ready to take the first part of this test.

If you have a question to ask, or if there is something you do not understand at any time during this test, raise your hand and your teacher or I will help you.

When you have finished the last section of this test, lay all six sheets of typing paper inside of your sheet of legal cap, and clip them together before handing them in.

SECTION A

GENERAL ORIENTATION--

COMPASS DIRECTIONS

LEFT AND RIGHT

In school you are learning to think. By thinking we can tell what would happen if things were different without actually changing them around. I want you to try some problems like that. You must listen closely and I will read each question twice. When I have finished the second reading you may write your answer but wait until you have heard the entire question twice. First we'll try one for practice. Ready.

1. The first problem is this--If you could walk on the ceiling of a room just as you do on the floor, which would be touching the ceiling, your head or your feet? -----Yes, that's right. It would be your feet, of course. All right, now--

2. If you were facing East, what direction would be behind you?

3. If your back were to the North, what direction would you be facing?

4. If you were facing South, what direction would be to your left?

5. If your back were to the West, what direction would be at your right?

6. Facing South, what direction lies behind you?

7. If your back were to the West, what direction would you face?

8. If East were to your left, what direction would be behind you?

9. If South were to your right, what direction would you be facing?

SECTION B

PUPILS' INDEPENDENT VERSIONS OF SIZES OF COMMON OBJECTS

(MATERIAL GATHERED FROM MULTIPLE CHOICE SECTION)

We are now ready for Section B. You may all write a capital B in the center of your page, on the next line.

There are many things which we see every day. I shall ask you some questions about how big some of them are. I want you to pretend that I have never seen these and you are telling me their size. If you were to ask me how high is the seat of a chair I would tell you it is as high as my knee. Or if you asked me how wide our dining room table is, I would tell you that it is forty-eight inches, or four feet, wide. If you asked me how big my picture of George Washington is, I would tell you it is the same size as a sheet of tablet paper. I want you to tell me the sizes of things in ways like these.

I have given you a piece of paper which says Section B at the top. It has this list of questions. I want you to copy the number of each question on to your legal cap and then write your answer. Be sure to take a new line for each new question.

If you finish before the others are through, look through the list again to see whether you could give me any better ideas about some of them.

SECTION B

TELL ME THE SIZE

100. How large is a cow?

101. How large is an apple?

102. How large is a bear?

103. How tall is a six-year old boy?

104. How tall is an ear of corn?

105. How tall are the corn stalks in the garden?

106. How high is the front door of your home?

107. How wide is your bedroom door?

108. How high does an apple tree grow?

109. How long is your nose?

110. How long is your little finger?

111. How long is your arm from your shoulder to your wrist?

SECTION C

ESTIMATES IN TERMS OF LINEAR MEASUREMENT

We are now ready for Section C. Everyone write a capital C in the center of the page, on your next line. Are you ready?

I expect that you have all measured things with a ruler, a yardstick, or a tape measure when you wanted to find out how long they were. That is the best way of finding out exactly how long anything is. But you might sometime wonder about the length of something when you did not have anything with you to measure it with. Then you would guess how long it was. I am going to ask you some questions and have you guess at certain measurements. Guess are carefully as you can, remembering the times you measured things and how long they were. As you answer the questions be sure to number each one and put it on a new line. Wait always until you've heard the second reading of the question before you write. Here is the first question.

200. How many feet long is this room?

201. How many feet wide is this room?

202. How many feet is it from the floor to the ceiling?

203. How many feet high are these windows?

204. How wide are these windows?

205. How many inches high is the table from which you eat, at home?

206. How tall is your teacher?

207. How tall are you?

208. Did you know your height without guessing?

209. If you were to stretch your arms out as far as you could reach, to the sides, shoulder high, how far would it measure from the fingertips of your left hand to the fingertips of your right hand?

210. How many inches long is your hand, measuring from your wrist to the end of your middle finger?

211. How many inches long is your foot, measuring from the back of your heel to the end of your big toe?

SECTION D

MULTIPLE CHOICE

We now come to Section D. Everyone write a capital D on his paper and then listen carefully while I explain how you take this part of the test. (Pause).

All right. In this section of the test I will ask you a question and tell you three answers. You are to choose the right answer from these three and write it down. Wait always until I have finished the second reading before you write.

First we will try one for practice.

300. Is a cow about the same size as

a sheep

a dog, or

a horse?

(Repeat entire question) All right--anyone? Yes, let's all write horse after our number three hundred because a cow is more the size of a horse than of a sheep or a dog.

As I read the rest of the questions write your answer for each one. All right.

301. Are apples about the same size as

watermelons

oranges, or

lemons?

302. Is a bear about as long as

an elephant

a lion, or

a skunk?

303. Are boys of six more than

one-third

one-half, or

two-thirds as tall as their fathers?

304. Are most ears of corn as long as the width of a

plate

length of a platter, or

width of a saucer?

305. Are corn stalks in the garden taller than

pear trees

sunflowers, or

wheat?

306. If you stand in the middle of your bedroom door, and stretch out both your arms, will you

have to bend your elbows (in order to touch both sides)

just be able to reach both sides, or

not be able to reach both sides?

307. Is your foot

about as long

once and a half times as long, or

twice as long as your hand?

308. Are apple trees as tall as
   a full-grown fir tree
   a two-story house (a house with an upstairs
      and a downstairs), or
   a rosebush?

309. Is your nose longer than
   your middle toe
   your middle finger, or
   your ear?

310. Is your whole arm
   shorter than your whole leg
   the same length as your whole leg, or
   longer than your whole leg?

SECTION E

MULTIPLE CHOICE

That is all of Section D. Write capital E on your page and we will go right on with Section E. It is a list of questions just like those in Section D. I will read the questions and three answers twice and then you choose the answer you think is right, and write it down. Number each and take a new line for each. All right.

400. Are apples about

3 inches

5 inches, or

7 inches through?

401. Is a large bear

4 feet

9 feet, or

13 feet long?

402. Are six-year old boys about

1½ feet tall

2½ feet tall, or

3½ feet tall?

403. Are the ears of corn which grow in your garden

8 inches long

14 inches long, or

20 inches long?

404. Is your front door at home

seven feet high

eight feet high, or

nine feet high?

405. Is the door of the bedroom where you sleep

20 inches wide

30 inches wide, or

40 inches wide?

406. Are apple trees usually

30 feet high

60 feet high, or

90 feet high?

407. Is your arm, from your shoulder to your wrist, less than

6 inches long

15 inches long, or

26 inches long?

408. Is your little finger

between 1 and 2 inches long

between 2 and 3 inches long, or

between 3 and 4 inches long?

SECTION F

ARRANGEMENT ACCORDING TO SIZE

You are now ready to work on Section F. Write a capital F on your paper. I have given you a page with twelve groups of words on it. We are going to arrange the words in each group according to the sizes of the things they name, always putting the largest one first. Let's work on the first one together. I will read through the first group of words in Section F. While I am reading, you decide which one is the largest animal.

500. Cat, Hog, Horse, Sheep.

Which one of those is the largest? Yes, of course, the horse is the largest, so write the number 500, and horse. Now, which is the next to the largest?

Yes, hog. Write that down after the word horse. Then which is the larger of the two that are left?

Yes, the sheep. Write that after hog and then cat, which is the only one left.

You now have all four written down but in a different order than they are on your printed sheet, because you have the largest one first, and then the next largest, and so on. Go through each of the other groups of words and rearrange them according to size, always putting the largest one first. All right.

SECTION F

ARRANGE ACCORDING TO SIZE

500. Cat, Hog, Horse, Sheep
501. Elephant, Cow, Dog, Whale
502. Sparrow, Rooster, Humming-bird, Turkey
503. Lamb, Rabbit, Bear, Wolf
504. Bantam hen, Duck, Lark, Goose
505. Dandelion, Forget-me-not, Violet, Sunflower
506. Pear, Apricot, Muskmelon, Strawberry
507. Plum, Huckleberry, Peach, Cherry
508. Walnut, Cherry-pit, Almond, Filbert
509. Grain of wheat, Bean, Pea, Grass-seed
510. Raspberry, Logenberry, Elderberry, Tomato
511. Turnip, Radish, Pumpkin, Cabbage

SECTION G

DRAWING OF HAND AND FOOT

(Tracing, for checking purposes on other sections)

You each have two clean sheets of paper. I want you to put one of them in a good position on your desk so you can put your left hand on it, palm down, with your fingers spread out, like this---. Then take your pencil in your right hand and draw an outline of your left hand and wrist for me. Be careful to hold your pencil straight up so your picture will look just like your hand.

All right. Has everyone finished? Then write 600, Section G, on that page.

I now want you to each take off your left shoe, put your other clean sheet of paper on the floor in the aisle at the right of your seat. Put your left foot on the paper, being careful to get your whole foot on the paper, even if you have to turn the paper cornerwise. Take your pencil and draw all the way around your foot, being careful to keep your pencil straight up. When you have finished , put your shoe on again and number this page 601, Section G. All right.

SECTION H

INDICATING AND ESTIMATING LENGTHS OF FAMILIAR OBJECTS

We are now ready for Section H. I have given you each a page numbered 13 and one numbered 14. Page 13 has eight problems on it, and Page 14 has four. Let's look at the first problem on Page 13. In the top space there is a question. It says, "How long is a blackboard eraser?" I want you to pretend that you take an eraser and hold it on your paper with the end just touching this line on the left, like this. Then put a mark where you think the other end of the eraser would be. Everything it asks about on this page will be something that you will have to pretend that you have here. Always put the one end on the line at the left, and put your mark as far to the right as you think that thing would reach. When you have put the mark down for each thing, guess how far it is from the left-hand lane and write in the number of inches on the dotted line that I have fixed in each space.

When you get to Page 14 you will have to measure up from the bottom. Put the mark as far up from the bottom line as you think the thing would reach. Be sure to write down how many inches long you think it is. All right.

How long is a blackboard eraser? ________ inches

How long is a match? ________ inches

How wide is a slice of baker's bread? ________ inches

How long is a dollar bill? ________ inches

How wide is a dollar bill? ________ inches

How wide is a silver dollar? ________ inches

How wide is a fifty-cent piece? ________ inches

How long is an egg? ________ inches

SECTION H

______ inches	______ inches	______ inches	______ inches
How long is a table fork?	How long is a table knife?	How long is a teaspoon?	How high is a drinking glass?

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TABLE I

5/21/2010
FT 198702 5 59 00
HF GROUP–IN